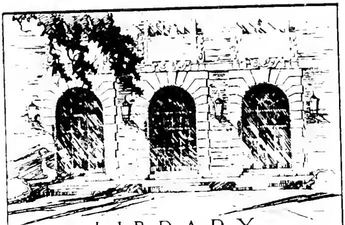

ON

WATER SUPPLY TO VILLAGES AND FARMS.

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The following paper contains the results of observations made by the writer during his lengthened practice as a Draining Engineer.

ON

WATER SUPPLY TO VILLAGES AND FARMS.

It certainly appears inconsistent with modern times, in which the drainage of lands and the sanitary condition of the people have been objects of profound interest and solicitude, that the water supply in rural parishes should remain unheeded, and that, while we have frequently to lament the great mortality of villages, and to trace disease to the absence of cleanliness in the cottages of the poor, we should disregard the advantage of a plentiful supply of water. It may remain optional with ourselves whether we pay heavily for losses by accidental fire for want of water to extinguish it, or suffer our stock to die of drought, or allow our steam-engines to remain idle in the field, or at the barn, for want of the element from which steam is generated; but we cannot longer defer the consideration due to the labouring poor with regard to the first essential of health and cleanliness—a necessary supply of water.

For two summers past a large part of England has suffered from want of water. Whole villages have been wretchedly supplied, and stock have been driven from their pastures morning and evening to seek water at distant ponds. In many cases water has been purchased at a cost so great as to add materially to the household expenses of the poor, and to deprive the grazier of profit from the summer's feeding; and although it may have been accidental for two seasons to succeed each other in which the same want has been felt, few agriculturists on the eastern side of England can fail to have observed that the insufficiency of water in summer is becoming more felt as years roll by. This is partly owing to the generally increased use of water by a population which itself is increasing, and partly to the ruling spirit of im-

provement, which will not allow any stagnant or surplus water, capable of removal, to exist on or within reach of the surface.

At the present time (February, 1865) the country is especially ripe for the consideration of this subject, inasmuch as the year 1865 commenced with a large deficiency of rainfall if we may take the recorded condition of the midland counties to represent that of the country generally. This deficiency will, probably, be felt in the coming summer and autumn more than at the present moment, because, although the subterranean waters of our wells are lower than perhaps any living man remembers them to have been at this season of the year, they will get lower still if the evaporating season sets in before the supplies are replenished. Two months more will bring us to that period when evaporation and vegetation will take up all the rain that falls, so that in the autumn, after the exhaustive demands of summer have produced their effect, the springs will be so reduced in height as to furnish matter of most serious inconvenience and loss.

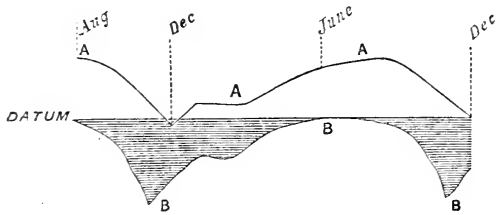
A short explanation of the effect of rain on the subterranean waters will, perhaps, supply some more definite ideas than at present prevail of the extent to which we depend upon the rainfall of particular months.

The meteorological year may be divided into two periods, viz.: The *non-evaporating* and the *evaporating*.

In the *non-evaporating* period,—so called for distinction only,—a large proportion of the rain reaching the surface descends by infiltration into the earth, and replenishes the water-bearing strata, from which our wells derive their supply, and from which springs burst at their outcrop to maintain the flow of our rivers. This period comprises the winter months from November to March, inclusive.

In the *evaporating* period, on the other hand, the quantity of rain penetrating beyond 3 feet deep into the earth is very small, and the water-bearing strata receive no appreciable replenishment. This period extends over the remainder of the year, from April to October, inclusive.

The following diagram shows how the rainfall is disposed of, and will satisfy all persons who may be interested in the subject, that it will not do for the inhabitants of our villages, nor, indeed, for the stock of our fields, to remain dependent for their summer supply upon rain falling in the summer, though it may often, providentially, happen that the rain is so heavy and frequent during the summer months as to allow of its being collected in sufficient quantity for present uses, in ponds, tanks, butts, and other receptacles.



Explanation of Diagram.—The space between the irregular lines A and B represents the total amount of rain falling on the ground. The datum line separates this space into two portions. The upper (light) portion between the line A and the datum shows the quantity of rain which reascends into the atmosphere by evaporation or is taken up by vegetation; the lower (shaded) portion between the datum and the line B represents the quantity which descends into the earth, and which, if collected, might be applied to useful purposes. This diagram is made on the assumption that all the land in the country is absorbent and equally so; but as this is not the case, a larger proportion than that figured above finds its way over the surface to the main outfalls in the time of floods, which might be intercepted and also applied.

The object of the present essay is not to suggest any means of making up a deficiency in the *subterranean waters*, which it is beyond our power to do to any appreciable extent, but to show in what way rural districts may be supplied by the application of surface and drainage waters as they flow, or by the storage of those waters.

Up to the present time our efforts seem to have been wholly directed to the removal of injurious surplus water, the effect of which has necessarily been to lower and reduce the quantity of water which hitherto stood stagnant in the fields throughout the summer, and also not unfrequently to lower the water in neighbouring wells at the same time. Thus, under-drainage has been attended by an incidental disadvantage which has gone some way to counteract its benefits, although it is manifest that as the effect of drainage is to discharge into the rivers water which has hitherto been evolved into the air, it may be made the means of originating a *new supply*, or at any rate of increasing the present one instead of reducing it, if works are designed for the purpose of turning it to account.

It is rarely, however, that a village is to be found in which the site has not in the first instance had some reference to a natural, though, it may be, an imperfect supply of water,

so that when the deficiency is felt it does not occur during the winter or spring when surface water is plentiful, but in the summer and autumn when evaporation and vegetation dispose of all the rain that falls, and when the subterranean water level is low in the ground beneath. In such cases a summer supply is all that is now needed, and where watercourses pass through a village or are near at hand, in which there is a plentiful flow during the winter, simple means present themselves for furnishing a summer supply. A pond or reservoir may be formed above the village, which may be filled from the brook by its being diverted into it; or, if this cannot be done, by the application of a hydraulic ram or wheel to raise the water from the brook into a reservoir at a higher level,—and thus any required quantity may be collected in the winter and preserved for use in the summer.

The best formed hydraulic rams, made by Easton and Amos, or Freeman Rowe, with an available fall in the stream of 7 feet, will raise to a height of 30 feet one-eighth of the quantity that sets them in motion, and assuming a reservoir formed above the village to receive the water raised, a stream discharging 23 gallons per minute during the winter and spring, will be sufficient to raise in 180 days 720,000 gallons for use during the summer and autumn.

A turbine or overshot wheel, might take the place of the ram with advantage, when the quantity of water to be raised is greater than that stated.*

But of course the expense of either ram or wheel and attendant works would be saved in those instances where water can be brought from a height and conducted at once into the service reservoir, with an overflow to discharge the excess when the reservoir is filled.

These modes of supplying a village or a farm homestead are so simple, that they would hardly be worth explaining were it not probable that their very simplicity is the cause why nothing is done towards adopting them, for it is notable in agriculture as in all the ordinary pursuits of life, that what can be readily done

* A recent invention by Mr. Macintosh, called the "Cumulative Screw," with fans formed like the Archimedian screw used for propelling ships, but multiplied in number, is adapted to streams of water of slight fall. It works on a shaft set in a trough or half cylinder, to fit the diameter of the screw, and the stream being directed through the trough, sets the screw in motion. Power is increased by lengthening the shaft and adding fans (*i.e.* multiplying screws), according to what is desired.

The writer does not at present know how far this invention may be applied in the utilisation of small streams and streams of slight inclination. The object aimed at is most important, but there appears to be certain contradictions to hydraulic principles involved in it which prevent a practical man from giving an opinion upon it until experience has proved its true capabilities. It will be a boon to agriculture if it should be proved that small streams with slight falls can be thus utilised.

is last done, and what can possibly be done without is left undone, if its doing will cost money.

If the process of collecting and preserving water and raising it into a reservoir for service to a village or homestead, be simple, the same may be said of the mode in which the inhabitants may be supplied from it.

A single pipe from the bottom of the reservoir, laid below the reach of frost, down a village street with pillar stand-pipes and taps, so contrived that when not in the hand they shall close themselves, will do all that is requisite, and prevent waste.

Some practical suggestions on the mode of utilising the water of drainage—the best of all water for domestic use—may now be appropriate.

By a careful consideration of the effects of under-drainage we shall find that in the majority of instances the population of whole parishes may be supplied during times of drought from the quantity of *new water* rescued from the atmosphere by the drainage of a few acres of land. The importance of such an application at the village and the farm comes with considerable force to the mind, when we remember that the poor of many villages have been paying as much as a penny a pail for water used for domestic purposes during the last two summers, and when we feel ourselves bound to admit that steam cultivation must eventually prevail in all heavy land districts. Those who have used steam know how necessary it is to have water within a short distance of the work, and how materially this advantage reduces the cost of the operation; but it seldom occurs to either the owner or the farmer, when taking the necessary preliminary step of draining their land, that it requires only the exercise of a little ingenuity to save a proportion of the water discharged by the drains in winter for use in summer, and so to secure in a simple and profitable manner, under their feet, that supply which in seasons of drought would be beyond their reach.

It is, nevertheless, an indubitable fact that a sufficient supply of water may be obtained by drainage if we will only go to some expense to collect it. The outlay, moreover, would frequently be very small, and would seldom fail to yield a profitable return.

The discharge of water from the drainage of clay lands is only for a limited time during the year; the drains commencing to run in the month of November, and generally ceasing in the month of May. If, therefore, any use is to be made of the water of drainage from clay lands, it can only be by collection during this period of discharge. The discharge of water from the drainage of wet free soils, on the contrary, is frequently constant throughout the summer as well as winter, and the drainage of such lands will therefore afford a much better

source of supply than that derivable from clay lands. This is one reason why it is so desirable that the appropriate drainage of the two characters of soil should be thoroughly understood and acknowledged by the general intelligence of the country, inasmuch as it is hardly possible to overdrain or to discharge water too quickly from clay lands, whereas it is certain that a multitude of drains in free soils not only effects a change adverse to a profitable maintenance of herbage during autumn, but discharges the water that finds its way into the soil directly from the heavens, and collaterally by pressure from the higher lands, with a quickness adverse to the maintenance of a perennial supply of water to our rivers. Without discussing here the question of *Land Drainage*, it may be admitted that all that is necessary in draining wet free soils, is to give motion to water which would otherwise rest stagnant within and upon them, and that the fewer drains that will do this, the better for the water supply of the country, because the evil of stagnation is removed with the least derangement of the natural *régime* of the rivers. Now, there are few villages, or farm homesteads, in the country which have not wet lands above them requiring drainage, either clay or free soil, for it may be observed that the clays which suffer most from their absorbent and retentive qualities, and the free soils which are most injured by springs, occupy the higher ground, and slopes of the hills. If this be so, drainage affords a means of supply to villages and homesteads by gravitation. But to turn the capability to a general account, it is necessary that neighbours should assist one another, and that the owners of lands, which by drainage can furnish a supply of water to others below, should combine with them for the purpose. Doubtless there are many estates of sufficient size to enable the owners to utilise the water of drainage, independently of their neighbours; but very few landowners so circumstanced, consider this question at all, in consequence of their farms being held by various tenants who are neither united in opinion nor disposed to look so far into the future, as to be willing to pay for the *use* of water which they only desire to be rid of. In fact, it is one of the most difficult things we have to do to satisfy, even those most interested, that the utilisation of drainage water can be profitable, *though in fact this utilisation is only secondary in importance to drainage itself.*

Instances might be given of the advantageous application of the water of drainage. The outlets of drainage systems have afforded a constant supply to whole villages, which would otherwise have been without water. Drinking places for cattle have been furnished by the flow of water discovered to be constant in the process of drainage. Wells to farm-houses

have been supplied, and where a constant discharge from drains has resulted from systematic drainage, the running water has been conducted through the cattle sheds and yards, in order that stock may always have fresh water as they require it.* Instances are not wanting in which the water of drainage has been used as a motive power of machinery, and for the purpose of irrigation, but these instances rather result from accident than from an acknowledged necessity of such provisions.

Last summer, as before remarked, was one of the driest on record, and as some proof of the immense advantage of a good supply of water, it may be stated that, wherever stock had a plentiful supply in the fields, the driest pastures became the heartiest feeding grounds, and cattle and sheep alike thrived well in spite of the apparent dearth of food.

Again, exceptional instances might be quoted in which steam cultivation proceeded throughout the whole of last summer, on farms that had been drained, and where the water of drainage had been collected to supply the engine, as has just been suggested for more general adoption.† It need hardly be said, however, that in the majority of cases cultivation was discontinued for a time, because of the scarcity of water.

We will now endeavour to show that there is no reason why this application of the water of drainage for domestic and farming purposes, should not become the rule instead of the exception.

In the published records of the discharge of drains in clay lands (see Royal Agricultural Society's Journal, vol. xx., page 273), it has been shown that the proportion of the rainfall discharged annually, varies from about one-tenth to one-fifth, according to the density of the soil.

Taking the mean of these proportions and the rainfall on the surface at 24 inches, the depth of water discharged would be 3 in. 6 dec.‡ or upwards of 80,000 gallons per acre. If we allow to each inhabitant of a village 10 gallons per diem, and assume

* In the works of the General Land Drainage Company, instances of the utilisation of drainage water may be seen in many of the counties of England. Mr. Thomas Scott has devised a very ingenious apparatus for keeping the water from a perennial supply, constantly flowing through drinking troughs, erected for the supply of cattle and sheep.

† The reader is referred to Mr. Cranfield of Buckden, Huntingdonshire, for proof of the advantage of conserving the water of drainage for steam cultivation. Although his farm is for the most part clay, and totally unprovided with spring water, Mr. Cranfield managed by the collection of water from his four feet drainage, to preserve a full supply, and was thereby enabled to cultivate with steam *all through last summer* (1864), and so secured the great advantage of a scorching sun to ameliorate the soil he turned up.

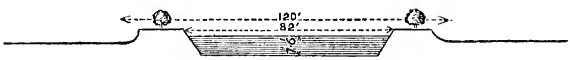
‡ An inch fall of rain on the surface of an acre of land is equal to rather more than 100 tons, *i.e.* 22,622 gallons ;if therefore we multiply this number of gallons by 3 in. 6 dec., the amount will be the average number of gallons discharged annually from each acre of clay land.

that for four months, or 120 days in the year, recourse would be had to the conserved supply, it would appear that 67 people may obtain a summer supply from each acre of land, if the whole discharge could be collected and used.

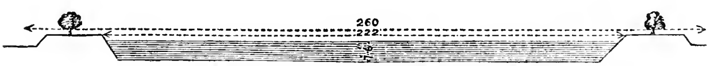
Now, if the average population of villages may be taken at 400 inhabitants, it would require only the drainage water of six acres to be collected to secure a reserve against drought for an entire village.

If the service reservoir be an open pond, a considerable allowance must be made for waste by evaporation, &c., and 50 per cent. on the quantity, *i.e.*, 15 gallons per head per diem, or the drainage water of 9 acres, should be provided, for a village. If a covered reservoir be adopted instead of an open one, the quantity may be reduced; but the expense of constructing a covered tank of sufficient size, will preclude its adoption, except in special instances.

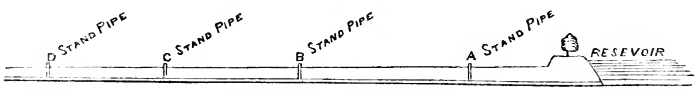
A pond large enough to hold 720,000 gallons,—the discharge of nine acres of clay land,—would take rather more than four tenths of an acre of land—net surface of water—7 ft. 6 in. deep.



TRANSVERSE SECTION OF RESEVOIR



LONGITUDINAL SECTION OF RESEVOIR



SECTION OF MAIN,
DOWN VILLAGE STREET.

The expense of making the pond, using the earth to embank it, and planting the embankment so as to exclude as much as possible sun and wind, and thereby to reduce evaporation and preserve the purity of the water,* would be as follows:

* Considerable objection is taken to planting round reservoirs, because leaves fall into the water and *cause impurity*. But when the reservoir is annually emptied and cleansed, this objection does not apply, and the advantages of shade are greater than the slight disadvantage of decaying leaves at the end of the season of supply.

Excavation and embankment, assuming that the earth thrown out formed a bank round the pond, on which trees and shrubs may be planted, 2500 yards at 6d.	£62	10	0
Puddling bottom and slopes, dressing banks and gravelling bottom 6 in. deep on the puddling, and constructing overflow from reservoir . .	102	10	0
Planting and fencing	30	0	0
Value of land appropriated to the purpose, ¾ of an acre	45	0	0
Total cost of reservoir .	£240	0	0
Iron pipes from reservoir with stop-cock, well, and brickwork	155	0	0
4 stand pipes and taps	20	0	0
Total outlay . .	£415	0	0

Assuming these figures to fairly represent the cost of supplying a village of 400 inhabitants with water, and the number of houses or cottages in the village to be 100, it follows that the cost per person would be 20s. 9d., and the cost per house 4*l.* 3s. If the cost were charged upon the houses, and the money were borrowed to do the work, it could be repaid by instalments, with interest, in 30 years, at 6¼ per cent., and the annual charge would amount to 26*l.*, or a charge upon each house of not quite 5s. 3d. per annum.

The capability of thus supplying villages with water is not conjectural;—every day's experience in drainage only confirms the conclusion that there are few villages in which something of the sort might not be devised. In fact, the figures given represent the worst aspect of the suggestion, for nature frequently affords opportunities of collecting the water of drainage, without recourse to artificial ponds, in hollows and ready made receptacles which may be appropriated with advantage. The only thing necessary is an admission that the provision is positively required, and that it is an act of justice to charge it upon the properties that will derive benefit from the supply.

Turning again to farms:—as clay lands will derive the greatest amount of benefit from the application of steam cultivation, it is a desideratum of the highest importance that water should be at command during the summer, when the stirring of the soil secures the greatest benefit. And as all clay lands will be drained, which are not already drained, ere steam cultivation acquires its proper

position in agriculture, it is only necessary to provide a sufficient supply for the engine when draining the land.

Wells at certain intervals are perhaps as cheap a mode of conservation as any, or ponds will serve the like purpose. A steam-engine of 10-horse power requires for the cultivation of an acre of land from 100 to 125 gallons of water—say 125 gallons—and a well 12 feet deep and 6 feet in diameter will hold, if rendered water-tight and properly covered over, 2115 gallons, or a supply sufficient for the cultivation of 17 acres. It will only be necessary when carrying out any system of drainage, to multiply the wells or ponds according to this calculation in proportion to the number of acres of arable land on the farm.

It may be fairly asked,—If these objects can be so simply attained why they have not been carried out during the great progress of drainage? The answer is soon given. The necessity has not been acknowledged, and until that is the case nothing will be done on any extensive scale.

THE END.

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